DRAFT FINAL
EXPANDED ENGINEERING EVALUATION/COST ANALYSIS (EEE/CA)
FOR THE
McLAREN TAILINGS SITE
COOKE CITY, MONTANA

Engineering Services Agreement DEQ/MWCB 401027
Task Order Number 05

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2.0 SITE BACKGROUND

2.1 MINING HISTORY

Placer gold was discovered on upper Soda Butte Creek in 1869 and the first lode claims were staked the following year. At the time of discovery, the New World Mining District was part of the Crow Indian Reservation and mining was conducted under trespass on Indian lands. Consequently, sponsors were reluctant to invest in the area until after 1882 when the reservation boundaries were reduced. Once legal title to mining property could be obtained, attraction to the New World Mining District was renewed and hundreds of claims were staked throughout the area. Development of mines and prospects was limited due to the high cost of mule-back freight and interest in the district languished when attempts to build a railroad into Cooke City, Montana, failed (GCM, 1985).

Smelters were constructed in the New World Mining District in an attempt to counteract high transportation expenses. In 1889, the Montana State Mine Inspector documented three smelting facilities in the New World Mining District (Swallow, 1889). One of these smelters was a portable furnace located north of Cooke City, Montana, along Miller Creek. Another was the Great Republic Smelter, the ruins of which can be found below Cooke City on Woody Creek. The exact location of the third smelter, the 20-ton per day plant of the Eastern Montana Mining and Smelting Company, is unknown. Though the exact location of this early smelter is not recorded, there is speculation that it was located on Soda Butte Creek in the vicinity of the McLaren Tailings Site.

In 1933, the McLaren Gold Mines Company discovered the McLaren deposit on Henderson Mountain. The McLaren mine ore consisted of limestone and shale replaced by auriferous pyrite with some copper mineralization. The ore was mined on a non-selective basis using open cut methods. In 1934, a flotation mill was constructed on the Copper Glance mill site near Cooke City, Montana, and a tailings impoundment was constructed on the adjoining Horseshoe and Greeley placer (Hart, 1935). The McLaren Mill produced a gold and copper concentrate that was shipped to Anaconda, Montana, for smelting. Extensive exploration work at the mine in 1937 and 1938 resulted in the discovery of additional reserves and the mill was remodeled to increase capacity. During the operation of the mill, Soda Butte Creek's channel was filled with tailings and the stream was pushed into a ditch and culvert that ran along the south side of the impoundment (Johnson, 1949) (GLO, 1946). The McLaren Mill operated until 1953 when excess stripping ratios at the mine made the operation unprofitable (Goddard, 1953).

During operation of the McLaren Mill, tailings disposal was problematic as overflow from the tailings impoundment flowed downstream into Yellowstone National Park. Inspections by Park Rangers documented a regular pattern of leaks and breaks in the earthen dike surrounding the tailings impoundment. While the daily operation of the mill tended to give a milky appearance to Soda Butte Creek, the frequent breaks and washouts of the impoundment had more serious consequences (Johnson, 1949). A Park Ranger inspecting a breach in the impoundment dike in June 1950 documented repairs made to the impoundment but noted that similar breaks in the dam occurred each spring and more breaks could be anticipated with continued operation of the mill (Johnson, 1950).
Closure of the mill in 1953 did not end the concern about downstream environmental impacts

resulting from the McLaren tailings. By the late 1960s, Soda Butte Creek was considered the most polluted stream entering Yellowstone National Park. Investigations into the cause of the pollution showed that ferrous iron precipitates and heavy silt loads from the tailings were adversely affecting the fish producing capacity of Soda Butte Creek within the Park (DOI-BSFW, 1969). In 1969, Bearcreek Mining, the site owner and a Kennecott Corporation subsidiary, rehabilitated the site by covering the eroding tailings with soil, demolished the buildings at the site, and excavated a new channel for Soda Butte Creek along the north side of the tailings impoundment (DOI-BSFW, 1970). Since completion of the initial reclamation work at the McLaren Tailings Site by Bearcreek Mining, the site has continued to be studied by State and Federal agencies.

2.2 HISTORY OF ENVIRONMENTAL IMPACTS

Over the past 30 years, a multitude of engineering and environmental studies have been conducted at the McLaren Tailings Site and along Soda Butte Creek, immediately downstream from the site. Several of the studies have focused on assessing the stability of the tailings impoundment and associated earthen dam; the majority of the studies have focused on assessing the environmental impacts to Soda Butte Creek (water quality, riparian vegetation condition, aquatic life condition, flora and fauna species diversity, etc.). These studies unanimously conclude that the McLaren Tailings Site is a significant contributor to the poor water quality in Soda Butte Creek.

The McLaren Tailings Site is a significant source of acid drainage, conductivity, hardness, sulfate, iron, copper, manganese, and zinc in Soda Butte Creek. In general, the water quality in Soda Butte Creek improves downstream, as distance from the McLaren Tailings Site increases. Appendix G contains an annotated bibliography of all previous research and environmental and engineering studies conducted on Soda Butte Creek and the McLaren Tailings Site (USGS, 1999).

It is not the intention of this EEE/CA to target and examine fate and transport of specific contaminants of concern (COCs), to quantify contaminant loading in surface water or groundwater, or to document historical exceedances of water quality standards in Soda Butte Creek or the associated groundwater aquifer. Environmental problems associated with the McLaren Tailings Site have been well documented from as early as the 1950s to present time. The focus of this EEE/CA is to develop and evaluate practical reclamation strategies (alternatives), from an engineering standpoint, that would significantly reduce or eliminate the environmental impacts contributed by the McLaren Tailings Site.

2.2 CLIMATE

The Cooke City area has a continental climate modified by the high mountain setting. It is characterized by large daily and annual temperature ranges and marked differences in precipitation, temperature, and wind patterns over distances of only a few miles.

Precipitation and temperature data have been collected periodically at Cooke City, Montana, from 1967 through 1995. The eastern side of Cooke City is approximately 0.10 mile from the McLaren Tailings Site. The Cooke City station is located at an elevation of 7,460 feet above

mean sea level (amsl), which is similar to the McLaren Tailings Site elevation of 7,600 to 7,700 feet amsl. The average annual precipitation for the period of record is 25.38 inches. Temperatures are coldest in January with an average minimum of -16.5 degrees Celsius (^{o}C) (2.4 degrees Fahrenheit [^{o}F]) and an average maximum temperature of -4.8 ^{o}C (23.3 ^{o}F). Temperatures are warmest in July with an average minimum temperature of 3.3 ^{o}C (37.9 ^{o}F) and an average maximum temperature of 22.8 ^{o}C (73.1 ^{o}F).

Precipitation and temperature vary with elevation, which ranges from 7,400 feet amsl at Cooke City to 10,500 feet amsl in the higher elevations. Freezing conditions can occur any day of the year. Precipitation records from a Soil Conservation Service SNOTEL station (SCS Station TX06) at an elevation of 9,100 feet amsl in the Fischer Creek drainage indicate that the average annual precipitation at this location is 60 inches. Fifty percent of the annual precipitation occurs between October and February, with January being the highest average precipitation month (14.4 percent) and August having the lowest average monthly precipitation at (3.9 percent). Average annual snowfall at the higher elevations is about 500 inches.

A meteorological station was maintained in upper Fischer Creek near a proposed mill site for various periods during exploration activities by Crown Butte Mining, Inc. Data collected from this site for the period of May 1992 through August 1993, indicate an average wind speed of 5.4 miles/hour and a prevailing direction from the northwest.

2.3 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

The McLaren Tailings Site is located in the Beartooth Mountains, a mountainous region that has been subject to extensive uplift and thrust faulting, exposing Precambrian crystalline rocks (Foosse et al, 1961). The site is located in a valley that is drained by Soda Butte Creek, an east to west flowing stream which runs through the site and eventually through Yellowstone National Park, five miles downstream. The valley is steep-sided and has morphological and lithological characteristics typical of glaciated landscapes.

The McLaren Tailings Site is characterized by three general geologic units:

1. Precambrian and Tertiary age intrusive rocks that comprise the bedrock base.

2. Pleistocene age sediments consisting of alluvial sands and gravels, lacustrine silts and sands, fine to coarse textured glacial tills, and variable slope debris deposits.

3. Holocene age sediments and fill deposits resulting from the mining activity. These fills include mine tailings sediments, dam embankment or soil cap fills, and mine waste rock or stockpile ore deposits.

2.3.1 Regional Geologic Setting

Outcrops of bedrock are exposed on the valley walls adjacent to the site; however, on the valley floor the bedrock is obscured by overlying Quaternary deposits. Borings and seismic records indicate the bedrock contact is 0 to 65 feet below the ground surface at the site. The bedrock at the site consists of either light to dark greenish-gray granite, or dark to medium gray diorite (Elliot, 1979).

Pleistocene age deposits consist primarily of coarse-grained alluvial sediments that overlie the bedrock base. The alluvial sediments are mantled by a two to four foot surficial layer of glacial till. Lacustrine sediments occupy low gradient areas of the valley floor. These sediments range from 0 to 10 feet in thickness, and are deposited beneath the present tailings deposits (BOR, 1990). Slope debris of alluvial and glacial origin mantle the steeper sloping areas adjacent to the site.

2.3.2 Local Geologic Setting

The geology of the McLaren tailings are described in detail by Elliot (1973). The tailings area is underlain by moraine deposits of Pleistocene age covered with a thin veneer of recent unconsolidated stream deposits. Bedrock consists of coarse-grained granite occasionally intruded by fine-grained diorite dikes.

Areas adjacent to the McLaren tailings are typically comprised of stratigraphic units of Cambrain age which have been intruded by small sills and dikes. Areas adjacent to the intrusions were the zones that were first inspected for potential mineral development due to alteration of the host rock by oxidation and hydrothermal activity.

2.3.3 Hydrogeologic Setting

Groundwater conditions at the site within the tailings dam and tailings deposit are highly variable throughout the year. Monitoring well data indicates a 6 to 15 feet variation in piezometric levels between the seasonal low in March and the seasonal high in May.

Groundwater input into the tailings appears to be from the three sources listed below, although the relative contribution of each is uncertain:

- Overland and subsurface flow from sloping areas on the south and southeast perimeter of the site;
- Seepage from precipitation that falls directly on the tailings pond surface; and
- Inflow from Soda Butte Creek and Miller Creek which flows on the north and northeastern margin of the tailings pond including subsurface flow in the Holocene alluvium beneath the tailings deposit and dam.

In borings completed by the BOR, artesian pressures were encountered. These heads represent confined flow at depth in highly stratified deposits, rather than excess pore pressures just below the dam embankment.

Groundwater in the area is probably limited to unconsolidated alluvial deposits along Soda Butte Creek and a regional system in adjacent bedrock which appears to be controlled by secondary or fracture permeability.

The quality of groundwater in the McLaren tailings is variable and depends on the location within the tailings deposit with respect to the recharge area, local permeability, and proximity to the old Soda Butte Creek channel. The tailings groundwater generally exhibits a low pH, high Specific Conductivity (SC), high sulfate concentrations, and high dissolved and total recoverable iron concentrations. Other parameters which occasionally exhibit high concentrations include aluminum, lead, copper, silica, and zinc (David Stiller & Associates, 1983). Stiller identified a low pH cell near the center of the tailings. The cell is believed to represent an area where oxygen-bearing waters are introduced at a sufficient rate to more than offset weathering conditions (i.e., Soda Butte Creek alluvial gravels underlying the tailings).

Movement of water through the tailings is generally from east to west with some discharge occurring from seeps along the base of the dam and one significant spring at the southwest corner of the dam (David Stiller & Associates, 1983).

The Montana Bureau of Mines and Geology (MBMG, 1975) reports groundwater flow within the tailings toward and along the former Soda Butte Creek channel, near the southern perimeter of the tailings. Significant recharge to groundwater within the tailings is apparent at the eastern and northern contact with Soda Butte Creek.

2.3.4 Seismotectonic Setting and History

The study area is outside but near the eastern boundary of the Centennial Tectonic Belt and the Intermountain Seismic Belt, as defined and mapped by Smith and Sbar, 1974, Witkind, 1975, and Stickney and Bartholomew, 1987. These earthquake and micro-earthquake belts have generated historic, as well as Holocene and Pleistocene tectonic activity that is documented by Baily, 1977 and Stickney and Bartholomew, 1987. Seismic activity in the Yellowstone-Snake River Plain which is nearer to the project site, but well within the two earthquake belts, is addressed by Smith and Sbar, 1974. The principal historical earthquake affecting the site is the 1959 Hebgen Lake event (M_s about 7.5).

2.3.5 Surface Water Hydrology

Area streams are high energy, first and second order tributaries of the Yellowstone River system (B-1 classified, A-1 classified within Yellowstone National Park). These streams occupy glacially carved valleys and are fed largely by melting snow pack. Peak stream flow is characteristically reached by mid-June or early July and may be several orders of magnitude higher than base flow conditions, which typically occur in late winter or early spring.

The main surface water feature in the vicinity of the McLaren Tailings Site is Soda Butte Creek (B-1 classified), a perennial tributary to the Lamar River. Soda Butte Creek formerly occupied a channel beneath the present tailings site, but has been diverted around the northern perimeter of

the site. Significant tributaries to Soda Butte Creek include Miller Creek, Woody Creek, and Sheep Creek.

Miller Creek drains to the south side of Daisy Pass, the west flank of Henderson Mountain, and the east flank of Miller Mountain. Miller Creek flows southeast for approximately two miles to its confluence with Soda Butte Creek, which in turn flows west into Yellowstone National Park where it enters the Lamar River. Immediately above Miller Creek's confluence with Soda Butte Creek, a measured flow of 0.44 cubic feet per second (cfs) was recorded on September 25, 1997. The measured high flow at this location was 55.5 cfs on July 2, 1990. Although several minor historic mine disturbances are present in the Miller Creek drainage basin, Miller Creek water is largely unimpacted by acid rock drainage.

The drainage area of Soda Butte Creek above the McLaren Tailings Site is reported by George Maddox and Associates as 5.5 square miles (3,422 acres). This drainage area has a hydrologic soil group of C, a watershed condition as fair forest land, a curve number of 73, a hydraulic length of 15,300 feet, a watershed slope of 28.52 percent and exhibits the following precipitation events:

- 10-year, 24-hour = 2.4 inches;
- 25-year, 24-hour = 2.6 inches;
- 50-year, 24-hour = 3.0 inches; and
- 100-year, 24-hour = 3.4 inches.

Using these data and a Type II runoff chart indicates a maximum flow in Soda Butte Creek at the McLaren Tailings Site for each storm event as follows:

- 10-year, 24-hour = 670 cfs;
- 25-year, 24-hour = 835 cfs;
- 50-year, 24-hour = 1,226 cfs; and
- 100-year, 24-hour = 1,665 cfs.

2.4 CURRENT SITE SETTING

2.4.1 Location and Topography

The New World Mining District is located in Park County in south-central Montana and is bounded on the south by the Montana-Wyoming state line, on the west by Yellowstone National Park and on the north and east by the Absaroka-Beartooth Wilderness area boundary. The District is characteristic of high alpine regions of the northern Rocky Mountains with elevations that range from approximately 7,000 feet to over 10,000 feet amsl. Accumulated snow pack can range from 10 feet to over 20 feet deep where drifting occurs. The ground is generally snow covered from late October through mid-May at the lower elevations and from early October through late July at the higher elevations. Perennial and semi-perennial snowfields occupy the north facing slopes of the highest mountain peaks.

2.4.2 Vegetation, Wildlife & Fisheries

Aquatic life is generally absent downstream from the McLaren Tailings Site impoundment. High dissolved iron concentrations have been shown to be the primary cause of the absence of a fishery and benthic organisms in the reach of Soda Butte Creek below the tailings (Department of Natural Resources and Conservation [DNRC], 1977).

According to a study completed by David Stiller & Associates in 1983, based on their qualitative visual observations of the streambed in Soda Butte Creek (around and below the tailings), there has been little change since the (DNRC, 1977) investigation. The stream reach at and just downstream of the tailings appear quite sterile with little detectable periphyton or benthos. The aquatic ecosystem gradually improves with increasing distance from the McLaren Tailings Site and with tributary dilution. The DNRC concluded that if the iron concentrations in Soda Butte Creek exceed 0.2 milligrams per Liter (mg/L) at any time, no viable fishery would re-establish.

Montana Fish Wildlife and Parks, Fisheries Division, sampled two 1,000-foot sections of Soda Butte Creek in 1993 (MFWP, 1994). A 1,000-foot section located above the confluence of Soda Butte Creek with Sheep Creek yielded 32 Cutthroat trout from 3.2 to 13.3 inches long and from 1 to 4 years old. A second 1,000-foot section directly downstream from the tailings impoundment yielded only 2 fish, 1 Brook trout and 1 Cutthroat trout. Results of this sampling indicate that the McLaren Tailings Site continues to impact fisheries conditions on Soda Butte Creek, though conditions have improved since 1974 when electrofishing yielding no fish in a 300-foot section located about a mile upstream of the Yellowstone National Park boundary.

2.4.3 Historic or Archaeologically Significant Features

GCM Services completed a cultural resource inventory and evaluation of the McLaren Tailings Site for the Department of State Lands/Abandoned Mine Reclamation Bureau (DSL/AMRB) in 1985 (GCM, 1985). GCM concluded that the original mill complex had been completely destroyed and that the site had no structural remains that would contribute to the Cooke City Historical District. GCM found the site lacking in physical integrity and recommended that the site not be considered as eligible for listing on the National Register of Historic Places. The Department of State Lands consulted with the Montana State Historic Preservation Office about GCM's findings and the Preservation Officer concurred that the site did not qualify for listing on the National Register of Historic Places (Sherfy, 1985).

2.4.4 Land Use and Population

The communities of Cooke City and Silver Gate, Montana, are the only population centers near the New World Mining District. The neighboring communities of Mammoth, Wyoming and Gardiner, Montana, are located approximately 50 miles to the west. Red Lodge, Montana, is approximately 65 miles to the northeast, via the Beartooth Highway, and Cody, Wyoming, is located 60 miles to the southeast. The primary land uses in the immediate area include residential and the following recreational activities: hiking, biking, horseback riding, ATV/motorcycling, snowmobiling, and camping.

Only two routes of travel are open on a year-round basis: the Sunlight Basin Road, which provides access to within a few miles of the New World Mining District in the winter and Highway 212 (west of Cooke City) between Mammoth and Cooke City, Montana. The

Beartooth Highway 212 (east of Cooke City) between Cooke City and Red Lodge is closed during the winter.